

Research on symbiosis of man, ecology and industry based on catalyst theory

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ABSTRACT: Tianjin's industrial heritage has witnessed the development of China's modern industry and carries the city's memory. Focusing on the symbiosis of man, ecology and industry, we analyze the current situation of industrial heritage protection in Tianjin and apply the catalyst theory to the conservation and renewal of industrial heritage. Taking the Tianjin Steel Mill and Tianjin Medium Plate Mill in Tianjin as an example, based on the results of the questionnaire and the catalyst properties of the site, a research framework of industrial heritage based on catalyst theory is constructed according to the characteristics of the site. We focus on how to guide the catalytic effect to make the industrial symbiosis with ecology and man, and finally achieve the sustainable development of itself and the area. The research on the symbiosis model of man, ecology and industry of industrial heritage based on catalyst theory is actively explored.

1. BACKGROUND

Recently, China's urban and rural development has entered a new era of spatial planning, with stricter spatial control of urban development boundaries and more significant practical significance for transforming and renewing urban stock space. As one of the birthplace of China's modern industry, the study of the stock of industrial land in the central city of Tianjin is the key to the optimization of the stock of industrial land in the Beijing-Tianjin-Hebei region.

2. RESEARCH BASIS AND FRAMEWORK

Catalyst theory believes that urban development has a chemical chain reaction: based on the original elements in the city, new elements are introduced to form new catalytic points. They generate catalytic reactions, in turn trigger a "chain reaction", activating the renewal and reorganization of the elements of the base. At the same time, exerting a radiating effect on the surroundings of the base and lead to continuous renewal of the city^[1].

Researches on the renewal of industrial sites based on

catalyst theory have been on the rise in recent years, with a large increase since 2016. In past studies, about 70% studied the continuity effect triggered by a single factory subject in industrial sites, while the attention to other subjects in industrial sites was weak. Based on this, we not only focus on the reuse of factories but also on the restoration of ecology, the reshaping of memory, the introduction of new business, and the relationship between the base and the surroundings^[4].

2.1. A framework for industrial heritage research based on catalyst theory

We constructed a framework for industrial heritage research based on the catalyst theory (Fig. 1). Firstly, the catalytic elements were selected and divided into material and non-material elements according to their characteristics and tangibility. The immaterial catalytic elements are based on the material catalytic elements, but are independent of each other. Subsequently, the catalytic element layer is superimposed, and the catalytic effect is brought into play by building, shaping and improving the catalytic elements. Finally, the purpose of revitalizing industrial heritage and driving urban development is achieved^[6].

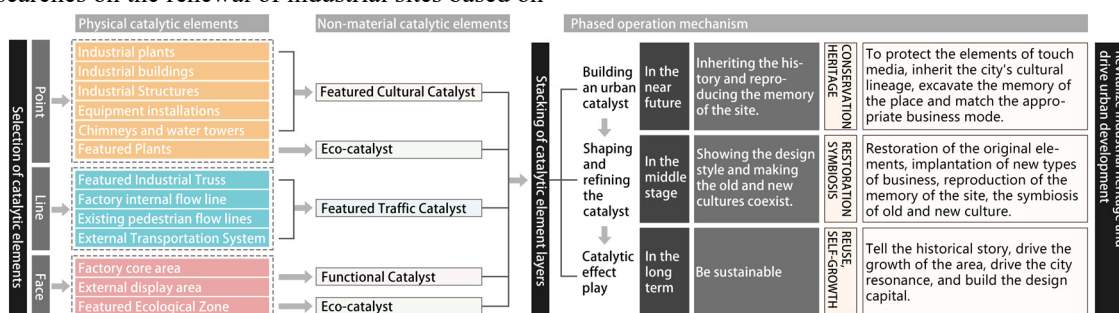


Figure 1. Research framework(self-painting).

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2.2. Composition and characteristics of the catalytic elements

The material catalytic elements include point, line and

Table 1: Classification of material catalytic elements

Elements	Contains the subject	Features	Role
Point catalytic elements	Mills, structures, devices, chimneys, water towers and characteristic plants.	Alone with vital space occupancy.	After being activated, a radiation is generated outward with it as the center, stimulating a chain reaction.
Line catalytic elements	Characteristic industrial trusses, existing flow lines and external transportation systems.	Connection, traffic, guidance.	To Link point elements, integrate scattered sites, build new flow, organize crowd traffic and play a guiding role.
Face catalytic elements	Inward facing spaces.	Clustering	To play the centripetal role of space and create a sense of place.
	Outward facing spaces.	Radiating	To Guide to strengthen the radiation of space and achieving the drive effect on the surrounding area.

2.3. Phased operation mechanism

The material catalytic elements should be restored and revitalized based on the protection. And they are excavating the non-material catalytic elements they carry to recreate the site's memory. After that, we will match the appropriate business mode and provide people with comfortable and exciting sequential urban space with the characteristics of industrial areas so that people and the site will be connected and the base will have lasting vitality.

The ultimate goal is to achieve the symbiosis of people, ecology and industry on the site, thus inspiring new life and bringing about a lasting catalytic effect and urban resonance. The purpose is to maintain its own characteristics and stimulate urban vitality.

3. TIANJIN HERITAGE SITUATION AND CASE PRACTICE

3.1. Distribution and Renewal Status of Industrial Heritage in Tianjin

The industrial heritage of Tianjin is mainly concentrated

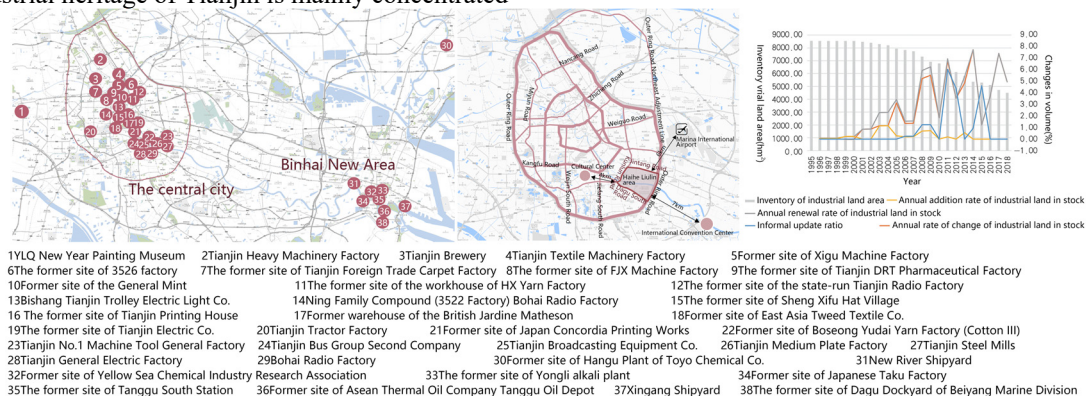


Figure 2. Tianjin industrial heritage distribution map (self-painting), comprehensive comparative analysis of data related to changes in the quantity of industrial land stock in the central city of Tianjin^{[2][10]} and location of Haihe Liulin Area(self-painting).

face elements (Table 1). Immaterial catalytic elements include cultural, transportation, ecological and functional catalysts. In a broad sense, have the location potential, historical story and spirit of place of the base^[8].

in the central city and Binhai New Area (Fig. 2), accounting for nearly 80% of heritages. Since 2001, the area of stocked industrial sites in Tianjin has gradually decreased; since 2014, the annual addition rate has maintained 0%; since 2000, the annual renewal rate has fluctuated and increased^[5].

3.2. Interpretation of base location characteristics

The base is located in Dongli District, Tianjin, in the southeastern of the central city of Tianjin, and also in the sub-centre of the main city, which is strategically located. It is spatially connected to other industrial heritage in the central city through significant traffic arteries, railroads and the Haihe River; and is expected to serve as the core, exemplary and leading role in the Haihe Liulin Region, and as a gateway to the industrial heritage in the central city(Fig. 2).

3.3. Interpretation of catalyst properties around the base

Comprehensive analysis of the 2km range around the base industry, population distribution and traffic (Fig. 4): 1km around the base business accounts for about 12.5% of the

overall analysis range. The 1km support around the base accounts for 12.7% of the general analysis range (Table 2) (Fig. 3). Land resources are wasted, industrial resources need to be updated; uneven distribution of population, the base near the periphery of the distribution is less, and a small range of external traffic is blocked.

Table 2: Overview of the distribution of businesses and supporting facilities around the base.

Business	Dining	Retail	Recreation	Education	Fitness	Life services	Financial insurance	Wellness	Vehicle service
Quantity	682	1040	138	249	97	750	58	240	199
Complementary	Residence	Businesses	Offices	School	Hospital	Subway stations	Public stations		
Quantity	96	9	14	49	48	42			

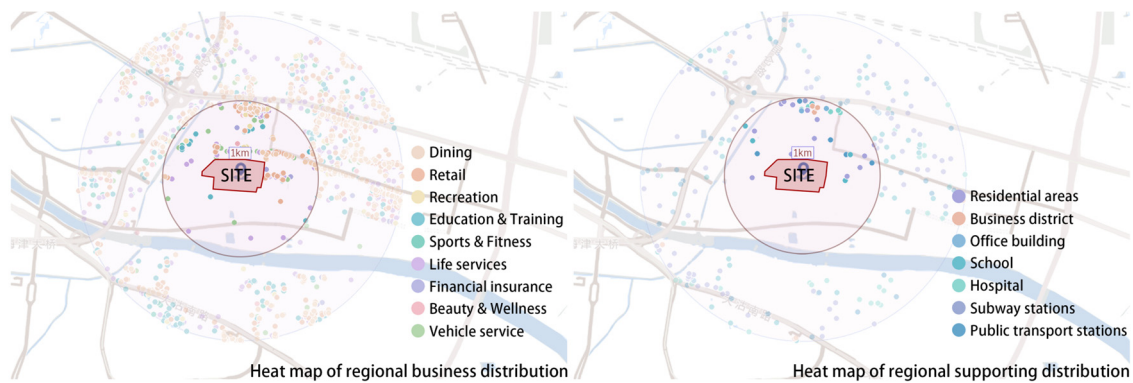


Figure 3. Business and complementary map(self-painting).

3.4. Thinking and innovation of base catalyst update

(1) Analysis of the difficulties of transformation

With the abandonment of the mill, the old buildings on site only have the function of displaying the industrial relics of the city and do not play their guiding role well; they ignore the importance of the symbiosis of different elements of the base and cannot coordinate well with the surrounding area. The key point of renewal is how to stimulate the vitality of the mill through renovation to

achieve the symbiosis of different elements^[3].

(2) Transformation innovation point discovery

In the renewal of the factory, the focus is on the inheritance of industrial history, the restoration of the ecological environment and the attraction of people to achieve the reorganization of urban resources. It was renewing, shaping and improving different elements separately and introducing new businesses. In terms of ecological restoration, the environment will be repaired. Ultimately, the base will be renewed into a symbiosis that integrates the harmonious development of the subjects, further driving the growth of the area^[7].

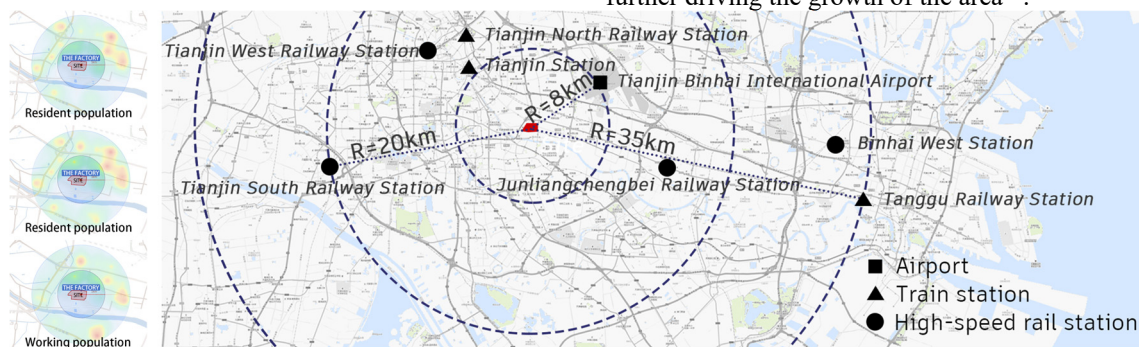


Figure 4. Population and traffic distribution map(self-painting).

4. INDUSTRIAL HERITAGE RENEWAL DESIGN BASED ON URBAN CATALYST THEORY

4.1. Catalyst shaping strategy

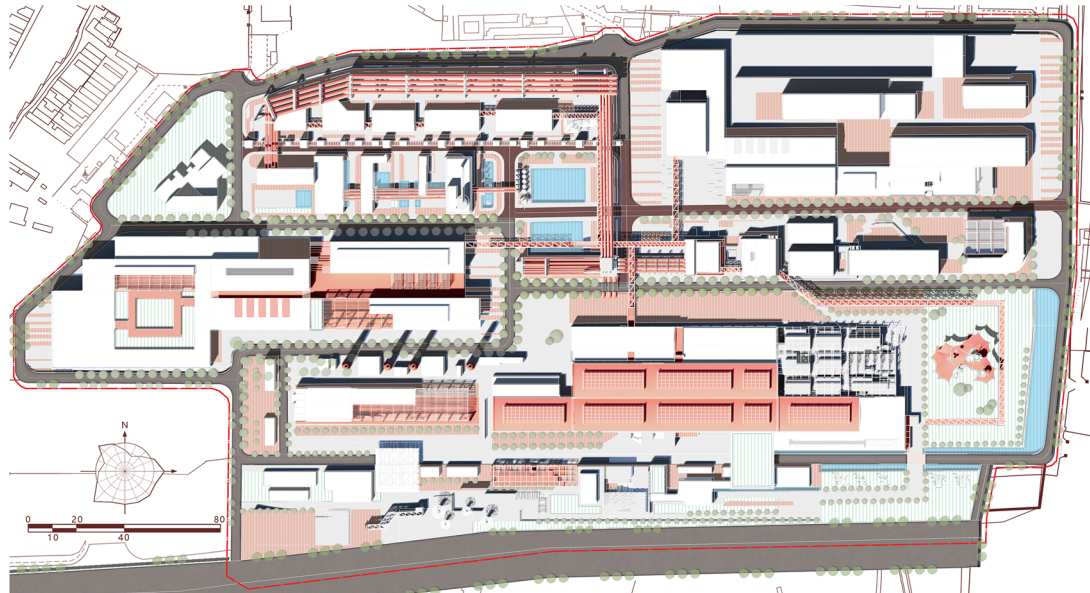


Figure 5. Design plan(self-painting).

Based on the above study, we developed a questionnaire on people's impressions of the base and interviewed 59 people in and around the base within 1km. We summarized the following seven problems: lack of orientation in the internal areas; lack of experience in the preserved heritage; the low presence of annexes and

structures; confusing organization of the transportation system; lack of central public space; lack of main entrance space; and ecological resources not being well utilized. Our strategy was determined based on the above issues (Table 3)^[9]. The design plan of the site is shown in Figure 5.

Table 3: Questionnaire results and catalyst shaping strategies.

Elements	Subject	Analyze the questionnaire and summarize the existing problems (Number of people)	Strategies	Purpose
Point	Plants	Severe damage and poor visual experience (37).	Restore the original façade and structure. Re-divide the functions: add special exhibition area, immersive experience area, bar, graffiti exhibition hall, etc. Increase the internal vertical design (Fig. 7).	Revitalize the venue and attract different people to interact with it.
		Factory abandonment, lack of experience (50).		
		Large volume, lack of space guidance inside (43).		
	Chimney	Too industrial, lack of experience (51).	Interesting transformation between plant, chimney and water tower. Selecting a chimney and expanding the volume and adding different functions of the compound. (Fig. 6).	Serves as a site marker and crowd experience site.
		The overly tall shape is intimidating (35).		
	Annexes	Not paying attention (21). Poor experience (38).	Orderly spatial reorganization with new business forms.	Energizing the factory.
Line	Structures	Curious (45).	Retention, restoration and introduction.	As a memory carrying entity.
		Not paying attention (14).		
	Sidewalks	Poor landscape (28).	Preserve the existing sidewalks. Design the surrounding space.	Enhance beauty and guidance.
		Lack of guidance (37).		
	Truss	Want to go up to see (49).	Strengthen connection with ground.	Create interest.
	Transport	Gives a sense of immersion (46).	Repair the original track and reorganize the track flow.	For crowd experience.
Face	Drive way	Mixing with sidewalks (35).	Installation of separate driveway and parking areas (Fig. 8).	Meet the traffic demand.
		Lack of parking (49).		
		Lack of central space (49).		
		Poor sense of belonging (49).	Form a central spatial sequence enclosed by the main plant.	Build a central experience area.

	Factor y core area	Weed growth around the plant (42).	Renovation design for three factories and their surrounding spaces.	Build a multi-functional plant experience area.
		No experience space around the plant (35).		
		Lack of connection between plant and chimney (49).		
		Lack of interest (49).		
	Factor y extern al area	Lack of iconic entrance space to the site (23)	Reform the original fence and surroundings on the south side and the space on the east side.	Enhance the south and east entrance spaces.
		Lack of commercial space at the site (35)	Integrating and renovating the south side annexes.	Build a modern business district.
	Ecolo gical area	Overgrown vegetation (53)	Conduct ecological restoration, brownfield restoration and landscape creation	Build ecological experience area.
		Sparse vegetation affects the view (21)		Build camping base.

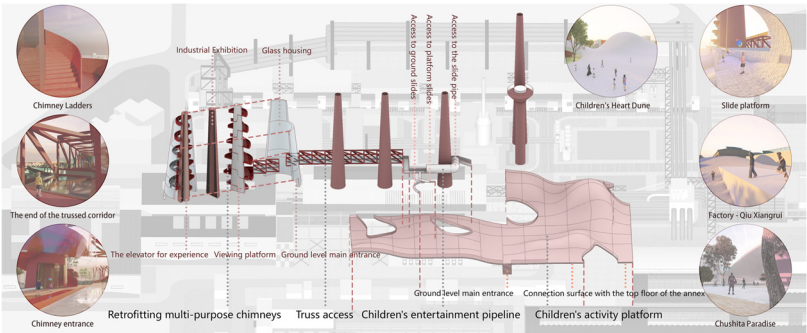


Figure 6. Exploded view of chimney(self-painting).

4.2. Design implementation plan

Shortly, we will protect and inherit the characteristic catalytic elements of the site by preserving the catalytic elements, inheriting the cultural lineage, excavating the memory and matching the right business. To achieve the purpose of inheriting the history and reproducing the site's

memory. Identify and protect the elements of the base with unique historical, cultural and aesthetic values so that they will be retained as the original elements of the site and inherit the impressive cultural lineage of the site. At the same time, the story behind the site will be explored, the memory of the place will be searched for, and the new types of businesses that can revitalize the area will be initially matched.

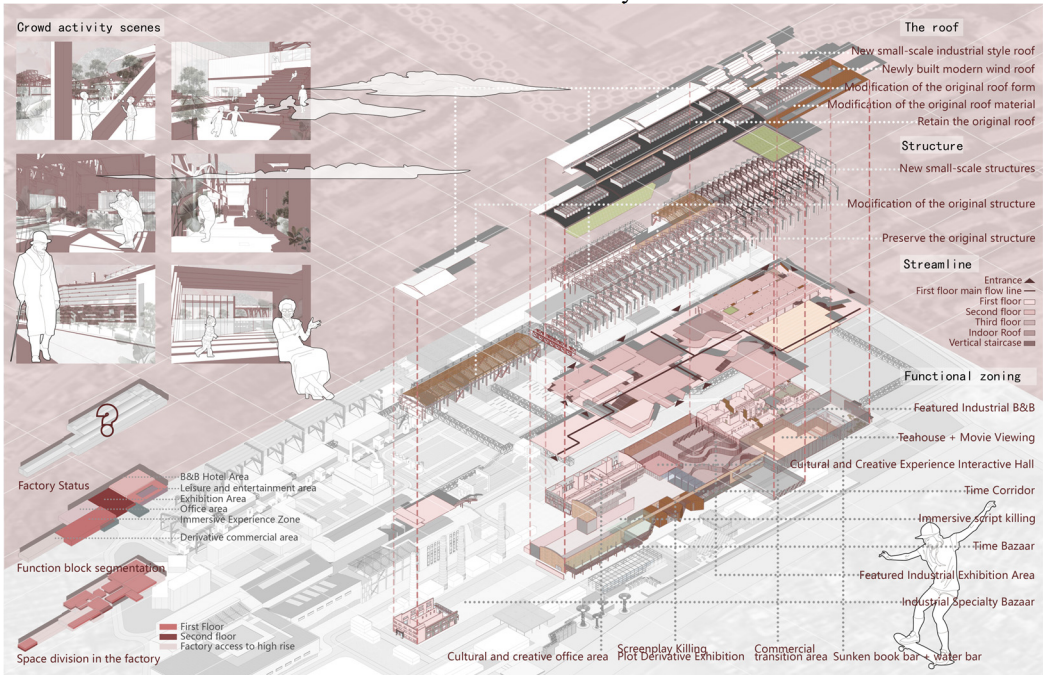


Figure 7. Exploded view of plant(self-painting).

In the middle stage, the characteristic elements will be renewed by restoring the original elements and implanting new types of business. New elements will be introduced,

and the catalyst system will be improved to show the design style and make the old and new cultures coexist. By shaping the identity elements, new expressions are

integrated into the architecture and environment to inherit the regional and industrial civilization and enhance the cultural connotation of industrial heritage. By implanting new business modes and attracting new designers to update the base continuously, people's memories of the site and the city will be evoked, thus realizing the symbiosis of old and new cultures.

It will be sustainable in the long term by guiding and

controlling the catalysts and bringing into play the catalytic effect. Tell the historical story inside the base, and drive the area to grow into a wide area integrating historical and cultural memorial exhibitions, modern business, future dynamic development and self-growth. It will also radiate to the areas outside the area, drive the active growth of the city, and create the design capital of Tianjin.

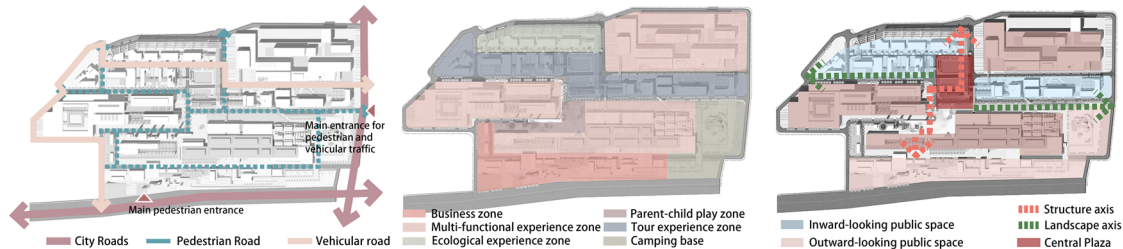


Figure 8. Road space, functional zoning and spatial structure analysis map(self-painting).

5. CONCLUSION

For the research and practice of industrial site optimization, Tianjin Steel Factory and Tianjin Medium Plate Factory are typical representatives of industrial heritage renovation and renewal design under the stage of realizing the transformation and renewal of stock industrial sites.

This design focuses on the symbiosis of man, ecology and industry as well as the sustainable development of the

site, forming the following three points: first, analyze the advantages and mechanism of catalyst theory for the reuse of industrial heritage, and then improve the catalyst through catalytic design methods include selection, acceptance and integration to achieve the symbiosis of man, ecology and industry. Finally, the hierarchical operation mechanism of catalyst theory is discussed from the perspective of the near, medium and long term, which is an active exploration of the industrial heritage renewal model based on catalyst theory. The aerial view of the site is shown in Figure 9.



Figure 9. Aerial view(self-painting).

REFERENCES

- Atton, W. & Logan, D. 1989. American Urban Architecture: A Catalyst for Urban Design. Taipei: Chuang Hsing Publishing House.
- Li, R.B. 2017. Study on the spatial and temporal evolution characteristics of the stock of industrial land in megacities and the transformation mechanism. D. Tianjin University.
- Liu, B.Y. & Feng, Z.P. 2009. Urban industrial land regeneration and industrial heritage conservation. Beijing: China Construction Industry Press.
- Lu, L.S. & Jiang, H.T. 2022. A study of industrial heritage renewal model based on mixed functional development. J. Industrial Construction. 52(4), 35-39.
- Ren, Y.L. & Guo, L.J. 2018. Exploration and practice of industrial heritage conservation and utilization in Tianjin. J. Urban Development Research. 25(10), C16-C31.
- Sun, Y. 2014. A Study on Industrial Heritage Renewal Strategy Based on "Urban Catalyst". D. Chongqing University.
- Wang, J.G. 2008. Conservation and renewal of industrial architectural heritage in the post-industrial era. Beijing: China Construction Industry Press.
- Xu, Y.W. 2017. Conservation and Reuse of Industrial Heritage of Zhongxing Coal Mine in Zaozhuang Based on Place Spirit Creation. J. Industrial Construction. 47(7), 63-67.
- Zeng, Y. 2015. Study on the conservation and revitalization strategies of industrial heritage in Taiwan from the perspective of touchmedia. D. South China University of Technology.
- Zeng, P. & Li, J.X. 2020. A study on the spatial and temporal response of the renewal of industrial land stock and policy evolution: the case of central city of Tianjin. J. Urban Renewal. 2020(3).